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THE LEHIGH QUARTERLY.

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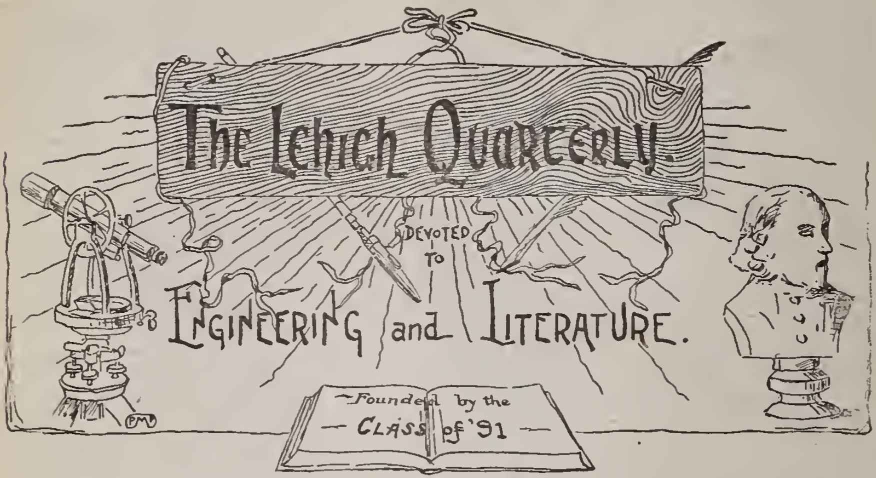

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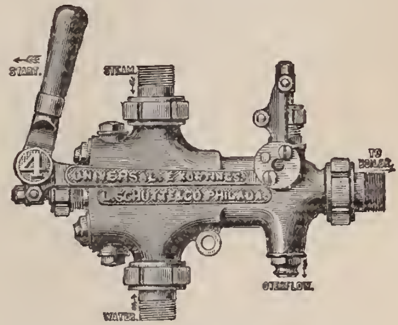

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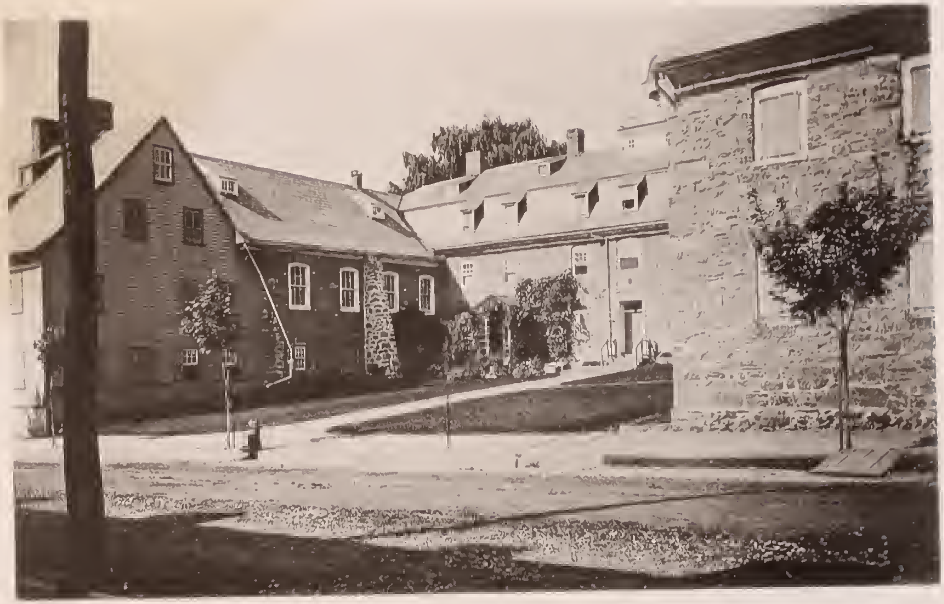

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ENGINEERING AS A SCIENCE AND AS A PROFESSION.

What is meant by the term "Engineering?" What is included in it?

It may, perhaps imperfectly, be defined as the exploration of the constituents of inanimate nature; the codification of the laws governing it; the reduction and application of its forces and its materials to the practical uses of mankind.

Mathematics is its cousin-german and its indispensable ally, by the aid of which it becomes, approximately, an exact science, though it falls more or less short of that perfection through the interference of natural sequences which cannot be wholly anticipated, nor be absolutely guarded against, though the possibility of such interference is, year by year, diminished by the results of experiment, and by the accumulating knowledge of the elementary causes which thus may interfere with the attainment of certainty in the engineer's prevision of the operations of inanimate nature.

In this view engineering is a science—that is, a far-reaching, organized *knowledge*—of the highest grade; one which contributes, in an unexcelled degree, to the material good of mankind, and one without which their physical wants cannot be supplied; one by which the supplies for these wants, prepared and deposited by the Creator, are developed and made available *pari passu* with the growth of the needs of the great human family.

Engineering is no merely abstract science, stopping short at the vindication of theories, or even at genuine discoveries. Its preëminent purpose is to turn the abstract into the concrete. Its objective point is *actual utility*, the application to present use of whatever is or may become known, and can be proved to be true and reliable in physics.

It is a great dissolvent of theories without bases in facts.

It is grand, for its thoroughness of investigation and the width of its range—the whole field of inanimate nature.

It is grand too, for the need mankind have for it, and for the benefits its results produce. It is eminently a most useful science. Its promise for the future, for what it shall yet accomplish for human welfare, no man can measure.

It is no narrow pursuit; it is not limited to one single branch of knowledge or research, as many suppose. It is a tree whose roots reach deep down into the arcana of nature, and feed a giant trunk and its many branches. It gives full employment to the highest faculties in each and every of its specialties, civil or military. There are electric engineering, hydrographic, topographical, mining, mechanical, etc., for its enquiries embrace all that belongs to inanimate nature, and yet each special branch is so bound to all the others that any research in one brings knowledge appertaining to the others, and all branches are connected in one common brotherhood of usefulness.

As a pursuit engineering is surely and truly a learned profession, based upon the knowledge gathered in the past, layer on layer, stratum on stratum, course upon course, until it has become the accumulation from which the minds of the present are drawing, and to which they are adding, day by day, materials of infinitely increasing value, an accumulation of practical knowledge the application of which is constantly making human life easier and happier.

As a profession, faithfully practiced, engineering calls for all the capacities for labor, all the endowments of intellectuality, all gifts of patient and impartial analysis and synthesis, a judicial ability for rigid accuracy and severe truth in its conclusions.

It demands in high degree the *perceptive* as well as the reflective faculties, and, withal, of all men a thorough engineer needs that rare faculty of sound judgment which we call "common sense" to test and temper and anneal all his theories.

It is a source of magnificent educational training to mind and body. Every faculty of both is taxed and trained,—the limbs, the eye, the hand, the temper, the nerves. The engineer must be a judge of human nature, for he has to deal with every variety of mind and character. He must combine firmness with self-control, clearheadedness with rigid honesty and fidelity to the rights of those whom he represents. He must, too, be a correct judge of every production of nature which he may have to pass on.

There is no calling in life, neither in law nor physic, which calls more faculties into use, and presents a greater variety of subjects of all grades to the mind. The true engineer is continually educating *himself* in the great university of nature.

The operations of an engineer bring him into close association with *realities*—not with impalpable and fine-spun fancies—with the realities of nature herself; and to those who love her and seek truly to know her, she, with maternal affection, bestows royal gifts of knowledge, wide breadth of mind, with vigor of body nourished on her bosom.

In one respect the engineer is above the mere *savant* who pecks at the vast mountain of knowledge and, when he chips off a little piece, or uncovers a little space, at once elevates himself into a grand inventor or creator of knowledge above even the God who made and used, and is still using, the knowledge, and but lets the *savant* see a glimpse of it. The engineer's habit and training is to bring discoveries to their real measure, and he at least can realize the proportion between what has become known and what is still unknown, and that his Maker is still the possessor in perfection of the knowledge which he is searching for.

It is not every one who can be an engineer. It is not every one, though liberally endowed with brains, who can be a first-class farmer, mechanic, jurist, doctor, or clergyman. Many who would excel in one calling fail in some other unadapted to them. Many a good doctor is spoiled in an inferior jurist.

But to one whose bent and adaptation is to engineering there is no wider, nobler, or more fascinating profession (other than that of the clergy), none which is doing more to create a community of interests and intercourse among nations, or to bring the diverse peoples of the earth into closer identity by a unity of supply of wants and needs they have in common.

This crude paper is not intended to be exhaustive. It is meant simply as suggestive of thought in others. If it succeed in this it is content to be as the seed, which, though reproduced in the crop, is duly buried and forgotten.

JOHN M. ORR.

HISTORICAL BETHLEHEM.

Bethlehem, at its best, is a beautiful little town about fifty-six miles from Philadelphia and ninety-two miles from New York.

Nature has given it a lovely setting and surrounded it with beauties that few towns can boast of. Here a person with a disposition for tramping can find unending pleasure, in walks over wooded mountains into the fertile valleys, along shaded roads by the side of the wandering river, and, go where he may, there will he always find views that will amply repay for miles of walking. One who has seen the Saucon Valley from old South Mountain on a June afternoon has had a treat that few have enjoyed and one that will never be forgotten. Nature has been so unsparing in her gifts to Bethlehem that one is apt to forget that man has done something to make it an interesting spot.

When one hears the name of Bethlehem surprise is expressed at its oddity, but the people, so long dead and forgotten, who named it had good reasons for so doing.

It was in March, 1741, that twenty people located at this point and began a settlement, hoping to form a quiet, religious home for themselves. They were simple, devout people, called Moravians. By Christmas they had only a dwelling and stable completed, all under one roof. The only place they had for their

Christmas festivities was the stable, and here they were held. The similarity between holding the celebration in the stable and the occurrence of the event celebrated, both having taken place in a stable suggested itself so strongly to their minds that they decided to name the town Bethlehem after the Bethlehem of Judea.

In the old Moravian Cemetery on Market Street there is a simple grave like all the rest, with its stone on top having carved in it the history of its owner, "David Nitschman, founder of Bethlehem, who felled the first tree to build the first house. Born Sept. 18, 1676, in Moravia. Died April 14, 1758." As can be seen, he was but a simple carpenter, and pictures of the first house for which this man felled the first tree are very numerous. So began the settlement. It grew very slowly and had many setbacks. A very good idea can be formed of what a quaint, quiet old place it was in the early days, and later on, after the effects of the Revolutionary war had died away, from a book written by a Mr. Ogden, of New York, called "An Excursion into Bethlehem and Nazareth in 1799." The town in those days had such a great reputation for healthfulness and beauty that many families came here from the South to spend the summer, while their daughters attended the seminary. But even in those early days the seminary girls did not venture forth unless under the charge of a teacher, and Lehigh University was then unknown. It can only be surmised that Muhlenberg was in its glory then.

The town was reached by means of stages running over the old Philadelphia Road, now known as the road to Friedensville. The writer of this little book was most thorough in his description of the place and people, and most of it is very interesting. He says the water works consisted of pumps to force the water up to the water tower, which stood where the old Moravian Church now stands. The pumps were operated by a wheel deriving its power from the Monocacy Creek. The old building which contained these pumps is still standing on the bank of the creek next to the spring which has always supplied water for the town. The water tower was fifty feet high and from this water ran through wooden pipes. The main from the works to the tower was of lead, four inches in diameter. Professor Merriman was not long ago addressing the Senior Civil Engineers, and, having occasion to go into an adjoining room, began searching through his pockets for a bunch of keys, when, much to the astonishment of the class, he brought forth, not a bunch of keys, but two long splinters of wood. After a smile had subsided the Professor explained that they were pieces of the first water pipes laid in Bethlehem over a hundred years ago. They were made of pitch pine, and when raised there was a small amount of water in them.

These water works were the first in the United States and were built in 1762 by a Dane named Hans Christian Christiansen, though a simpler form already existed, having been built in 1754.

Probably the most curious thing in this curious old book is the following: "There was an animal in the town said to have come from Moscow, Russia. The weight was eleven hundred pounds. Its proprietor supposed it to be of the same species which is described in the 14th chapter of Deuteronomy as the Pygarg. It partakes of part of the bear, mule, and goat, is black like the bear, and possesses such strength as to be able to lift and overturn a horse with its head. The horns are short. One of these, with the jaw, eye, and shoulder bones of one side, is lower than the other. Her face, belly, and eyes are covered with long hair. The hoof is parted. The beard is that of a goat. It feeds upon hay and grass, is fattened by oats, and chews the cud."

It seems that even in those days shrewd Jonathan was doing a good show business.

The old cemetery is very interesting and is always visited by strangers. Some of the graves are worth noticing, but first it will be remarked that there is order and method in the way the graves are arranged. They run in long rows, each with its plain slab on top. In one-half of the cemetery males are buried; in the other half, females. The men are buried in one row, young men in another and boys in still another. Similarly on the female side. One stone is on the grave of a man who was the son of the principal chief of the Cherokee Nation, and it is recorded on it, that his *corps* was brought home by the Adams Express.

Another one is that of a little boy but a few years old, and on it is inscribed the following: "'How does our Savior look?' 'Right clean,' was his reply." It is said that the Indian whom

Cooper took for a model of his celebrated character, Uncas, one of the last of the Mohicans, is buried here, and the grave of a Mohican named Tschoop is pointed out as the one.

The custom of playing on trombones in the tower of the Moravian Church, either to give notice of the death of a Moravian, when the second tune shows the sex and age of the deceased, or at the love-feast or in the cemetery at a funeral, is a custom peculiar to the Moravians. It is stated that the first trombone players in America were Bethlehem Moravians. It is the custom in this church to place the corpse during the funeral service in the corpse house. The original house stood farther east than the present one, which is a recent structure.

The Moravians have kept, since 1741, in a journal, an accurate account of each day's doings. It was always the duty of some one to do this, and as a result they have in their archives a daily record of all events that are of any value whatever that occurred here during the last one hundred and fifty years. It is all recorded in German and it is through the kindness of a Moravian friend that the following historical facts and data are available, he having translated and noted many interesting events which are here recorded. The houses forming the Moravian property are most of them so very old that a few dates in connection with them may not be uninteresting. The oldest house, which stood back of the Eagle Hotel, was removed in 1823, and the oldest building now standing is the one known as the Gemein House, on the corner of Church and Cedar Streets in the rear of the large church. This is made of logs, though now covered with siding, and was built in 1741–42. Then in 1742 an addition was made along Church Street. In 1742 the stone building at the southeast corner of the court was built, now called the Sisters' House. It bears in the wall, about ten feet from the ground, a sun dial with 1744 cut in it. In 1745–46 the building in the rear of the court, known as the Bell House, was built. In 1748 an addition was made to the east end of the Bell House and in 1751–52 another building was put in, closing up the gap between the eastern addition to the Bell House and the rear of the Sisters' House. In 1749 an addition was made to the western end of the Bell House, and then on the corner formed by this addition and the Gemein

House addition was built the chapel in 1751. In 1773 an end was put on the Sisters' House towards the east. The Widows' House, opposite the Sisters' House, was begun in 1773, the last wing, running south, being built in 1889. The original building of the Seminary, built in 1747–48, was known as the Brethren's House. It stands directly at the foot of Main Street. This group of buildings is so odd and quaint that it never fails to attract attention and arouse an interest in its history.

From the same journal there are obtained many interesting points in connection with the Revolutionary War and the movements of the famous men connected with it. It must be known first, however, that the majority of Moravians owed allegiance to to the King of England and so were Tories, and also that they were exempted by special act of Parliament from bearing arms. In the war they never fought, but rendered valuable aid to the Americans in the principal hospital of the army, which was located at Bethlehem. The principal hospital building was the one standing at the foot of Main Street, then known as the Brethren's House, but now as the Seminary building.

On the 27th of April, 1775, when the people of Bethlehem learned of the battle of Lexington, which had been fought April 19th, they hoped war would be averted, but shortly it was seen that it must come, and so on the 15th of May, at a township meeting six miles away (probably at Allentown), the people began raising troops to fight in the war for America. The Moravians were present at this meeting and declared their intention of not bearing arms. This meeting bore good fruit, for on July 8th and 21st volunteer provincial troops passed through the town on their way to Boston.

Shortly after, on the 23d of July, Col. Kichline, from Easton, came to the town and seized most of the arms, leaving a few for the Moravians.

One thing showing a change of opinion can be seen from the omission of the King's name from the litany prayer in the Moravian service on Sunday, the 28th of July. On July 30th one hundred and twenty men came through from Allentown, each of them having received three pounds sterling in hand for his enlistment.

On December 3, 1775, Dr. Shippen, director of the military hospital, arrived and reported that he had orders to establish a general hospital at Bethlehem; by the 4th work had progressed so rapidly in the preparation to receive the sick and wounded that Dr. Shippen and John Warren, Surgeon General of the Army, were very much pleased. Injured and sick soldiers were also to be sent to Allentown and Easton to be lodged in the court houses and churches. At this time there were one thousand men in the hospitals at Morristown, N. J., and one hundred and fifty more were coming to Bethlehem.

These last were American soldiers, and were quartered in the Brethren's House, or what is now the Seminary Building, standing at the foot of Main Street.

A question so often asked is one relating to the soldiers who were buried along the Allentown Road, west of the Monocacy Creek. Bones have been dug up there on several occasions, once when excavating for the foundation of a large barn, and again, more recently, in excavating for dwellings. Were these the bones of Hessian, English, or American soldiers? It is probably impossible to say, as all were buried along there, and no discrimination seems to have been made. The first notice to be found is one stating that on December 7, 1776, two men (Americans) died and were buried on the west side of the Monocacy.

On the 10th of December refugees from New York and Philadelphia poured in. Many officers and troops also came, Generals Gates and Sullivan being with them and they were accompanied by Mr. Livingston, signer of the Declaration of Independence. Every man of influence in this locality then was watched, and even on suspicion was taken care of. James Allen, founder of Allentown, was accused of having tried to persuade the militia to refuse to march, and on the 20th was taken by riders to Philadelphia to answer to the charge. How he was treated is not stated.

Wounded seem to have been coming in steadily, for it is stated that on December 17th from five to six hundred were quartered in the town, sixty-two having died during the month. At this time four thousand soldiers under Sullivan were camped around the town.

Early in the year 1777, on January 25th, John Adams, Mr. Lowell, and Mr. Hall, three Congressmen, passed through here on their way to Baltimore.

In the latter part of 1776 General Howe had made a proclamation, that inside of sixty days all rebels should lay down their arms. This sixty days expired on the 27th of January, and, though few knew of it, it is hinted that even these few did not dare to make any use of it even had they desired to do so.

A son of Dr. Shippen died on March 24th, and now a simple little stone bearing his name rests over his grave in the old cemetery.

On the 8th of April, General Gates passed through on his way to Ticonderoga. What his mission was is not known.

On the 11th of May heavy cannonading was heard. It will be noted that on a number of occasions battles taking place forty and fifty miles away were heard here.

In August, on the 23d, Generals Green and Knox arrived, but were immediately called away on account of the British under Howe landing in Chesapeake Bay.

On September 17th, when two hundred English prisoners arrived from Reading, there were no American sick or wounded in the town. Half of these prisoners were Highlanders. On the same day cannonading was heard to the southwest.

News was received on the 13th of September that General Washington had to fall back to Philadelphia on the 21st. Marquis Lafayette with a large suit arrived the same day. In the battle of the Brandywine, on the 11th, he had been wounded in the leg and was brought to the town to stay until his wound had healed. He was quartered at the Sun Inn, and staid there until nearly the middle of October.

When Howe landed in Chesapeake Bay, Washington hurried south to meet him to fight for the defense of Philadelphia. At the battle of Brandywine he was defeated and Philadelphia had then to be abandoned and all the personal effects of Congress, with the archives, were carted away and arrived in Bethlehem September 23d. Even the bells were not considered safe and were loaded on to wagons and carried through here, but the famous old State House bell stopped, since the wagon bearing it broke down. The other bells went on. On the next day came many members of Congress, including its President. The British, under Howe, entered Philadelphia on the 26th.

On the 27th, and on October 2d and 4th, cannonading was heard. It was the beginning of Washington's operations around Philadelphia, the battle of Germantown being fought on October 4th, and on the 7th the wounded began to come in.

The news of the surrender of Burgoyne, which had taken place on the 17th, was confirmed on the 25th, and Allentown and Easton went crazy with joy, shooting off cannons and having bonfires.

General Washington's baggage, which had been stored for three months in the old Burnside House, which stood north of Bethlehem, near the Monocacy, was removed on the 24th of December by a squad of forty men.

During the year 1777 over two hundred men, probably prisoners, died and were buried west of the Monocacy.

March 17th, 1778, St. Patrick's Day, was a day for the town people to remember, as, from what the journalist says, it seems that some Irish prisoners got drunk and behaved worse than a pack of drunken Indians, and, failing to start a fight with the town people, beat each other half to death.

On April 16th General Pulaski arrived and attended a Moravian service.

On May 17th Colonel Ethan Allen and General Gates arrived. John Hancock and others from Boston stopped over night on their way to Yorktown on June 15th.

The Indians under Butler had entered the Wyoming Valley, on July 3, 1778, and had killed nearly all the settlers at this point and Shamokin. The survivors began to arrive in Bethlehem ten days later, and were cared for by the people.

On June 15th, 1779, Lady Washington, escorted by Generals Sullivan, Poor, and Maxwell, with twenty other officers, came from Easton. The party was shown over town, and also attended a service conducted by Ettwein, the Moravian Bishop. Next day they left, Lady Washington and all declaring themselves well pleased with their visit. General Washington followed his illustrious lady three years later in a visit to the town. He spent the night of July 24th in the old Crown Inn. This famous old inn stood almost where the Lehigh Valley Railroad station now stands.

The next day the General came across the river into Bethlehem. He was unexpected and traveled with only two aids. He was the guest of Ettwein and visited the Brethren's and Sisters' Houses. It is said that the exact spot where Washington stood for some little time, in one of the rooms in the Sisters' House, is still pointed out. While at the Sisters' House he was given a dress for Lady Washington.

Next day he resumed his journey into New Jersey via Easton. Very appropriately, Washington, the great leader in the war which had raged so long and which he was bringing to such a successful close, was the last of the Revolutionary generals to visit Bethlehem. In those famous old days men whose names are forevermore famous were constantly passing through the town. Washington, Lafayette, Green, Gates, Mifflin, Sullivan, Pulaski, DeKalb, Schuyler, Hancock, Allen, Adams, Knox—the smallest school boy has heard the names and knows them well.

In the old cemetery are men who lost their lives in the hospital tending the wounded and dying American soldiers. Where the Lehigh man wanders now in search of knowledge, there once were the tents of the battling American army.

Volumes can and have been written on Bethlehem. One of the most interesting ones is the "Old Crown Inn," written by the Rev. Reichel for Mr. E. P. Wilbur.

THE THEORY OF CENTRIFUGAL VENTILATING FANS.*

Determination of their Forces and Dimensions.

BY LOUIS SER.

TRANSLATED BY JOHN T. HOOVER.

I. GENERAL THEORY.

1. INTRODUCTION.—A centrifugal ventilating fan is a machine which is composed of a number of straight or curved vanes mounted on a shaft, to which a rotary motion is given. The air drawn from one room enters the apparatus by an opening around the axis. It is then seized by the vanes which communicate their motion to it, and, under the action of the centrifugal force, it is driven to the circumference and from there into another room.

Ventilators are generally divided into *sucking* ventilators, *blowing* ventilators, and *exhausting and compressing* ventilators. The sucking ventilators draw in the air through a short or long channel and eject it directly into the atmosphere; blowing ventilators, on the contrary, take the air from the atmosphere and force it through an opening; exhausting and compressing ventilators have both an exhaust and compression channel. This last, then, constitutes the general case, and it is the one which we will consider in the theorem which follows.

2. Whatever the manner of action is, a ventilator has for its result the production of an increase of pressure upon the fluid which it puts in motion. We will express the pressures in tons of 1000 Kgs. per sq. m., or in meters of height of water. It is easily seen that in either case the pressure is expressed by the same number.

If p is the pressure expressed in this manner, the corresponding height of gas is $\frac{p}{d}$, d being the density of the gas compared with water.

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* Extrait des Mémoirs de la Société des Ingénieurs Civils.

The velocities will be estimated in meters per second. Letting h represent the height of water corresponding to a velocity v, we have $v=h\frac{v^2}{2g}$. The height of the gas is $\frac{h}{d}$ and p and h are quantities of the same kind.

For air at 150°, $d=0.0012257$.

$$\frac{g}{d} = \frac{9.8088}{0.0012257} = 8000$$

$$v^2=16000\ h, \text{ and if } h=0.001,$$

$$v=4 \text{ meters.}$$

In general, the increase of pressure which a ventilator must produce is very slight, being only a few centimeters; and in consequence, the density of the air varies very little in the different parts of the apparatus.

If we suppose an excess of pressure of 0.1 m. in height of water, the normal atmospheric pressure being 10.33 m., the densities will vary in the ratio

$$\frac{10.33 + 0.1}{0.1} = 1.0091;$$

that is, less than a hundredth.

The volumes will be so nearly the same, that they can be regarded as constant in the different sections.

Hence we see that we can apply to gas in these conditions the laws of motions of liquids, and notably, the theorem of Bernoulli, which is, *In the continual motion of a fluid, if the disturbance and mutual reactions be not considered, and if the volume moved is the same for each section of the passage, we obtain, for each of these sections, a constant quantity which equals the sum of*

1st, *The height due to the pressure,*

2nd, *The height due to the velocity,*

3rd, *The height of the centre of gravity of the section above a plane of reference.*

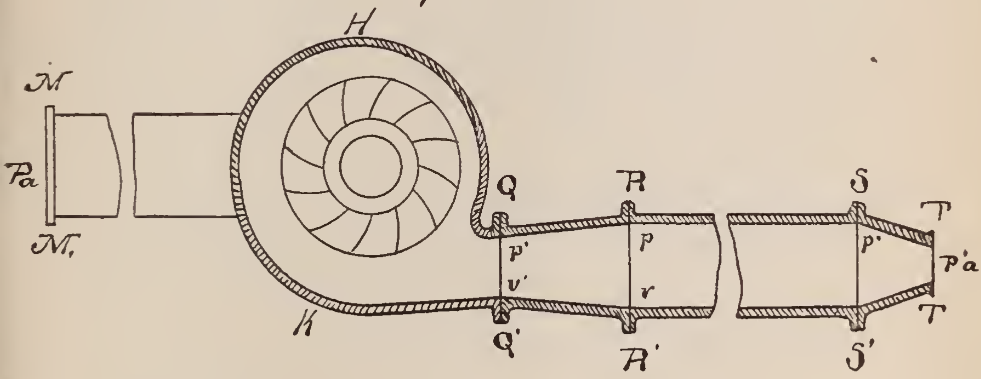
Calling the pressure p, the velocity in the section v, and the centre of gravity z, the theorem is expressed by the equations

$$\frac{p}{d} + \frac{v^2}{2g} + z = \text{a constant};$$

if the variation of z can be neglected, as is often the case, and if we put $h = d\frac{v^2}{2g}$, the equation is reduced to $p + h =$ a constant.

3. GENERAL ARRANGEMENT OF A CENTRIFUGAL VENTILATOR.—Figures 1 and 2 represent an 'exhausting and compressing' centrifugal ventilator. The air, drawn in from the room where the pressure is p_a through a conduit $M M' N N'$, enters the apparatus through the opening $A A'$, concentric with the axis, and called the *inlet* of the ventilator. It then turns at right angles, is seized by the vanes, which give it a rotary motion, and, under the action of the centrifugal force, it is forced into an envelope $Q H K Q'$ which ends in an exhaust port $Q Q'$ and from there by a channel $R R' T T'$ to another room where the pressure is p_a'.

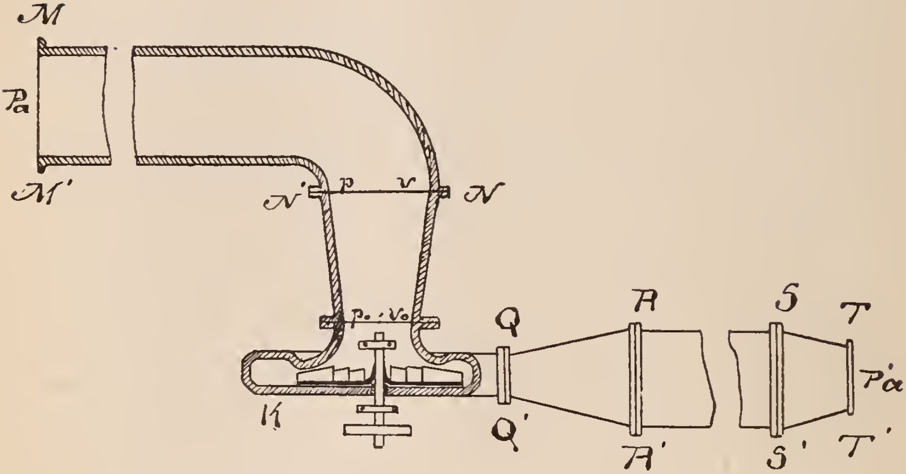
Fig 1



The pressures p_a, p_a' may be any pressures whatever, but they are usually both equal to the atmospheric pressure; and the ventilator has, in fact, to take in from the atmosphere a certain volume of air to make it circulate in channels placed in front of and behind the apparatus and to eject it into the atmosphere again.

In Figs. 1 and 2, the air enters the ventilator by only one opening $A A'$; but often there are two entering ports, one on each side, and the ventilator is then composed of two machines each similar to that shown in the figures and joined to each other. The results are the same as in the ventilator with only one inlet, but the volume is doubled.

Fig 2



Let us now study the motion of the air from the section of entrance of the exhaust channel in MM' to the end of the compression channel TT'.

4. Motion in the Exhaust Channel.—The air let into the room where the pressure is p_a penetrates the scction MM' T and ends in the exhausting channel. It comes to an end at NN' with a velocity v and a pressure p. In its motion it meets resistance from friction, back pressure, etc., and there results a loss of momentum which is sensibly proportional to the square of the velocity and can be represented by $Cd\frac{v^2}{2g}$ in height of water, C being a term which depends only on the nature and dimensions of the channel.

The difference of pressure, $p_a - p$, between the two extremities of the exhaust channel is composed of two parts:

First, The pressure

$$h=d\frac{v^2}{2g} \qquad (1)$$

necessary to produce the velocity v, since the air starts with no velocity.

Second, The loss of momentum $Cd\frac{v^2}{2g}=Ch$ produced by the resistance in the channel.

Then we have $p_a-p=(C+1)h$. (2)

We shall see further on how to calculate the value of C.

Let Ω be the section at $N N'$ and Q be the volume passing in one second, and we have

$$Q=\Omega v \qquad (3)$$

By means of these equations, knowing C from the nature and dimensions of the exhaust channel, the section Ω and the volume Q, we easily find the pressure p and the velocity v in the section $N N'$.

5. ARRIVAL AT THE EYE.—Let v_o and p_o be the velocity and pressure in the section Ω_o at $A A'$. The two sections, $N N'$ and $A A'$, being connected by a truncated cone sufficiently long, the air passes from one to the other without back-pressure, and we can apply the theorem of Bernoulli,

$$\frac{v_o^2}{2g}+\frac{p_o}{d}+Z_o=\frac{v^2}{2g}+\frac{p}{d}+Z,$$

Z_o and Z being the elevations of the centres of gravity of the sections $N N'$ and $A A'$. In general, their difference can be neglected and we have simply:

$$\frac{v_o^2}{2g}+\frac{p_o}{d}=\frac{v^2}{2g}+\frac{p}{d},$$

from which $v_o^2-v^2=2g\frac{p-p_o}{d}$. (4)

The volume which passes being the same for all sections, we have for the section Ω_o of the inlet:

$$Q=\Omega_o v_o. \qquad (5)$$

If R be the radius of the inlet,

$$Q=\pi R^2 v_o. \qquad (6)$$

In most ventilators the interior radius, R_o, of the vanes is equal to that of the inlet (R). We here take R smaller than R_o, however, in order to fit the inflowing air-pipe to the drum of the ventilator by an elbow very much rounded; we thus avoid the back pressure and the loss of momentum which always results from a sudden change of direction.

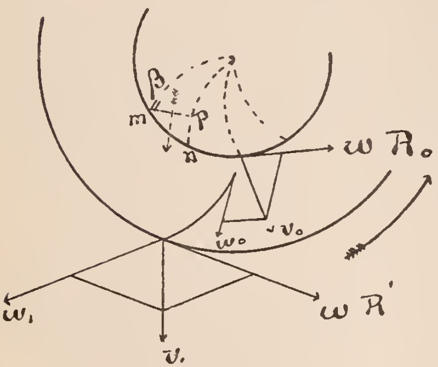
If we put $R=\mu R_o$, there results

$$Q=\pi \mu^2 R_o^2 v_o^2 \qquad (7)$$

μ^2 is less than unity; it can represent the coëfficient of contraction when there is no connection.

6. ENTRANCE INTO THE CHANGING CANALS.—The air enters the changing conduits formed by the vanes at a certain angle β which we could give it by establishing directrices, as is done in water turbines. In general, ventilators do not have them, but the rotation of the vanes produces a gyratory motion in the inlet from which results an inclined direction of the entering column as is shown in Fig. 3. Experience only can show what are the true angles of entrance, and the most favorable conditions.

Fig 3



If the sections and the forms are conveniently determined from the inlet to the beginning of the vanes, the pressure p_o and the velocity v_o remain constant, allowing for resistances.

At the entrance to the vanes, the normal section with the velocity v_o and making an angle β with the tangent is $b_o \Sigma pm$, b_o being the width of the wings at the entrance and pm a perpendicular to the direction of the velocity v_o. In the right angled triangle, pnm, the angle pnm being equal to β,

$$pm=mn \sin \beta.$$

The section is then

$$b_o \, \Sigma \, pm = b_o \sin \beta \, \Sigma \, mn = 2\pi \, R_o \, b_o \sin \beta$$

and consequently

$$Q = 2\pi \, R_o \, b_o \, v_o \sin \beta. \qquad (8)$$

At the entrance to the vanes the relative velocity w_o is the resultant of the velocity v_o and the velocity of the section $\omega' R_o$ takes in the opposite sense, from which we find:

$$w_o^2 = v_o^2 + \omega^2 \, R_o^2 - 2 v_o \, \omega \, R_o \, cos \, \beta. \qquad (9)$$

is the angular velocity of rotation. Calling the number of revolutions per minute N, we have $\omega = \frac{2 \, \pi \, N}{60}$.

Let θ be any angle which the relative velocity makes with the tangent at the circumference of the ray R_o and we have

$$v_o = \omega \, R_o \, \frac{sin \, \theta}{sin \, (\theta + \beta)}; \qquad (10)$$

$$w_o = \omega \, R_o \, \frac{sin \, \beta}{sin \, (\theta + \beta)}. \qquad (11)$$

This last relation does not constitute a distinct equation, for it can be deducted from the two preceding.

In order that the air may enter the changing canals without shock, it is necessary that the first element of the vane be in the direction of the angle θ. This condition can be realized only by determining properly the section of the entrance in proportion to the volume which must pass through it. If a ventilator be built in this way, it modifies the resistances to circulation, changes necessarily the volume drawn through with velocity v_o, and the relative velocity takes a direction more or less oblique to that of the vane, from which back pressure and disturbances at the port result.

7. RELATIVE MOTION IN THE CHANGING CANALS.—Let us now apply to a fluid filament the theorem of the effect of the work in the relative motion of a system turning with an angular velocity ω.

Let us decompose the filament into a very great number and successive masses (m), and let us consider the time in which one of them follows the next very short. During this time the increase of living force of the filament is, calling w the relative velocity at the end of the vanes, $\frac{1}{2} m (w_1^2 - w_o^2)$.

The work of the upward pressure p_o (pressure which is the same at the entrance to the vanes as it in AA', since the velocity v_o is the same and we suppose there is no back pressure) is

$$\frac{mgp_o}{d}.$$

The work of the downward pressure is

$$-\frac{mgp_1}{d}.$$

The sum of these works is

$$mg\frac{p_o - p_1}{d}.$$

The work of the centrifugal force on one of the masses (m) is $m \omega^2 x\,dx$, calling x the distance from the axis to the beginning of the time and $x+dx$ the distance of the following mass of which it takes the place; then for the whole fluid filament the work is $\frac{1}{2} m \omega^2 (R_1^2 - R_o^2)$, R_1 being the extreme radius of the vanes.

The work due to the weight can be neglected.

Finding the sum, we have

$$\frac{1}{2} m (w_1^2 - w_o^2) = mg\frac{p_o - p_1}{d} + \frac{1}{2} m \omega^2 (R_1^2 - R_o^2),$$

$$\text{or } w_1^2 - w_o^2 = 2g\frac{p_o - p_1}{d} + \omega^2 (R_1^2 - R_o^2).$$

We have left out in this calculation the friction and back pressure which always occur in the changing canals. To consider them, it is sufficient to remark that these phenomena constitute a resistance to the motion which manifests itself in a loss of momentum. Calling this loss f in height of water, the resisting work is $-mg\frac{f}{d}$, and the equation is then

$$w_1^2 - w_o^2 = 2g\,\frac{p_o - (p_1 + f)}{d} + \omega^2 (R_1^2 - R_o^2), \quad (12)$$

which comes from substituting $p_1 + f$ for p_1 in the preceding equation. The pressure at the extremity of the vanes is diminished by f.

8. ESCAPE FROM THE CHANGING CANALS.—At the end of the vanes the air escapes with an absolute velocity v_1, which is the resultant of the relative velocity w_1 and the velocity ωR_1 of the section. Calling γ the angle which the direction of the vanes makes with the tangent at the end, we have

$$v_1^2 = w_1^2 + \omega^2 R_1^2 - 2\omega R_1 w_1 \cos \gamma. \qquad (13)$$

The volume drawn through being the same for all sections and calling b_1 the width of the vanes at the extremity and supposing the motion to be with one end open, we should have

$$Q = 2\pi R_1 b_1 w_1 \sin \gamma. \qquad (14)$$

9. MOTION IN THE ENVELOPE.—Leaving the vanes, the air enters an envelope which leads it to the beginning of the pressure channel. It is important, in order to avoid the loss of living force, that the velocity in this envelope remain constant, or at least vary but little; and for this it is necessary to give it a spiral form, such that at each point and on each radius prolonged, the section will be proportional to the volume discharged, that is to say, in proportion to the portion of the circumference which gives escape to the air.

At the moment when the air leaves the envelope, if the velocity v_1 of the section Ω_1 of escape into $Q\,Q'$ before discharging the volume Q has been kept constant, we have

$$Q = \Omega_1 v_1. \qquad (15)$$

We have supposed that the pressure p_1 remains constant throughout the spiral. In point of fact, friction and back pressure produce a loss of momentum from the beginning of the spiral to the end.

To account for this, as for the loss at the introduction into the inlet, it is sufficient to change the meaning of what we have given to f as the loss of momentum produced by friction and back-pressure, not only in the changing canals, but even before and after the entrance to the end of the envelope, that is, properly speaking, in all the ventilator.

10. MOTION AFTER LEAVING THE ENVELOPE.—The section $Q\,Q'$ is joined to the section $R\,R'$, the beginning of the compression channel, by a part of a truncated cone made very long in order

to keep the passage with a full section. The air passes thus without back-pressure from the one to the other, from a velocity v_1 and a pressure p_1 to a velocity v' and a pressure p', and we have by the theorem of Bernoulli, neglecting the difference in height of the centres of gravity of the cross sections,

$$v'^2 - v_1^2 = 2g \frac{p_1 - p'}{d}. \tag{16}$$

calling Ω' the section at $R R'$,

$$Q = \Omega' v'. \tag{17}$$

The continuous increase of the secton has for its object the production of an increase of pressure by a decrease of velocity. As the velocity at the discharge pipe of ventilators is generally greater than that which is convenient to keep in the channel, we obtain by this very simple means a notable increase of useful effect. M. Guibal, engineer at Mons, conceived and applied with success this arrangement, aud experience shows in a most precise manner the truth of the increase of pressure as a consequence of the decrease of velocity when back-pressure is avoided.

11. MOTION IN THE COMPRESSION CONDUIT.—Starting at RR', the air empties into the compression channel and experiences, as in the suction channel, resistance which produce a loss of momentum. From RR' to SS' the pressure passes from p' to p'' and the loss $p'—p''$, proportional to the square of the velocity, can be represented by $Cd\frac{v^2}{2g}$, C being a term depending on the dimensions and nature of the channel. Calling h' the momentum corresponding to a velocity v', we have

$$h' = d\frac{v'^2}{2g}, \tag{18}$$

and

$$p' - p'' = C' d\frac{v'^2}{2g} = C' h' \tag{19}$$

In order to consider the most general case, let us suppose that the conduit at its extremity is built with one or more openings, which reduce or augment the section of passage in such a manner that the velocity passes from v' to v'', this last corresponding to a pressure h'', then

$$h''=\frac{d\,v''^2}{2g} \qquad (20)$$

If a change of section is made with a proper joint which avoids back pressure, we have by Bernoulli's theorem

$$p''-p'_a=\frac{d\,v''^2}{2g}-d\frac{v'^2}{2g}=h''-h', \qquad (21)$$

and combining the two equations (19 and 21) we find

$$p''-p'_a=(C'-1)\,h'+h''. \qquad (22)$$

The ventilator in fact makes the volume Q pass from the pressure p and velocity v to the pressure p' and velocity v', or, which is the same thing, the pressure $p+h$ to the pressure $p'+h'$.

The equations which we have just discussed permit a resolution of the different questions relating to ventilators.

(*To be continued.*)

[REPRINT OF THE TRANSACTIONS OF THE AMERICAN INSTITUTE OF MINING ENGINEERS.]

A RAPID METHOD FOR THE REDUCTION OF FERRIC SULPHATE IN VOLUMETRIC ANALYSIS.

BY CLEMENS JONES, HOKENDAUQUA, PA.

(New York Meeting, February, 1889.)

The difficulties attending the reduction of ferric sulphate in the determination of metallic iron by the method of Marguerite are often serious, and affect time, patience, and accuracy. They depend upon the condition and purity of the zinc used, the state of saturation of the solution, acidity, and temperature.

D. J. Carnegie (*Chem. News*, lvii. No. 1481,) says that ferric solutions are instantaneously reduced by the use of zinc-dust. But there are obvious objections to its employment in quantitative work. Dr. Drown found that "a concentrated solution, not too acid, was reduced by five grammes of pulverized zinc in two or three minutes, without other heating than that due to the chemical action." But the zinc in excess of the stoichiometrical amount must be dissolved. This has been the main obstacle. Large excess of sulphuric acid, heat, or both, must then be employed, and either involves loss of both time and accuracy in the volumetric method.

Marguerite's method is in point of celerity and refinement the most scientific of all the "iron methods." If the iron solutions have been properly prepared, the end-reaction is sharper and more quickly obtained than by any other. There is no loss in testing for final oxidation, as potassic permanganate is its own indicator. Besides, the permanganate solution can be most quickly prepared and accurately standardized.

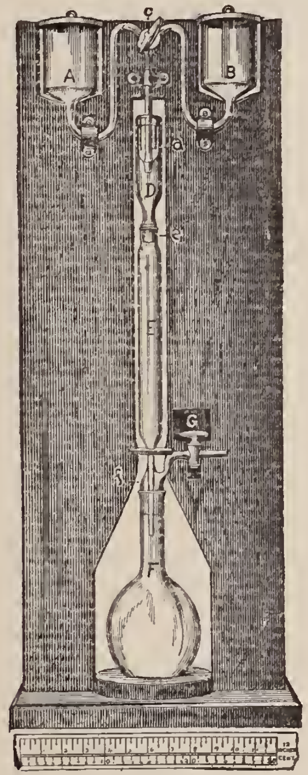
Hence there is a natural preference for this method in determining metallic iron. It permits direct and rapid titration. Only facilitate the reduction of the ferric sulphate, and it is the most valuable of all methods, combining the utmost rapidity with the highest accuracy attainable.

There is no difficulty in obtaining iron as ferric sulphate; but the reduction of this to the ferrous state has hindered the precision of the permanganate method. Discrepancies in results are all to be set down to the errors introduced in the reduction with zinc. The care to secure complete reduction—how frequently is it lost through the presence of a minute grain of zinc, washed down from the neck of a flask in titrating, and how derisively tossing up a little chain of hydrogen bubbles! Again, a very hot solution will decompose an excess of reagent. And, moreover, as I shall again remark, it is probable that the largest impurity in pulverized zinc is not iron, as heretofore supposed, but carbon.

The size of the particles of the pulverized zinc employed in the method which this paper describes is determined by passing through a 40-mesh upon a 60-mesh sieve.

Observing the action on zinc of ferric solution in sulphuric acid, I noticed that in all cases, with practically the same amount of acid and zinc, the latter dissolved more rapidly when the solution was more highly saturated with ferric salt; that the time for reduction, under the conditions mentioned, was dependent on the strength of the ferric solution. This was evidence that a sufficient number of zinc particles should be exposed, in a proper ratio to the ferric salt; that each molecule takes the same time to reduce, when unaffected by its unreduced neighbor, which is the time of contact; and that, therefore, were each molecule presented to new particles of zinc successively reduction would be instantaneous. Filtering the ferric solution through pulverized zinc would then demonstrate this fact, which I found to be the case. *A solution of ferric sulphate is instantaneously and completely reduced by filtering through pulverized zinc.*

The apparatus figured below was designed for the rapid reduction of ferric solutions. It consists of two cups* *A*, and *B*, of



Reductor, for the Reduction of Iron Solutions by Filtration through Zinc.

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* I find this form of cup not so convenient as the bulb-shape of a separatory funnel of the same capacity.

about 300 c.c. capacity, the outlets of which connect alternately, by means of a three-way cock *C*, into the joint-tube *D*. This tube is provided with a packing space *d*, which is filled with an asbestos roll, kept in place by a ring of cork. The tube moves up and down freely. At its lower end *e*, it is ground to fit the detachable tube *E*. This is for the pulverized zinc, and at its lower end has a stopper *f*, ground to fit the titrating flask *F*, of about 700 c.c. capacity. The stop-cock *G* connects with the vacuum-pump. The tube *E* is disconnected by pushing it up, grasping the neck of the flask with one hand, removing with the other the round block which supports the flask, and then detaching the flask *F*. The tube *E* now rests on the little shelf shown in the cut. This is drawn out, and frees the tube at its ground-joint *e*.

A wad of fine glass wool, sufficiently thick to make a good filter, is inserted into the tube, and the pulverized zinc is filled, over this, for four-fifths the length of the tube. This holds about 300 grammes, which is enough for sixty filtrations. The tube is then replaced by reversing the manner of removal, connection is made with the filter-pump, and the apparatus is ready for use. It is first necessary to wash the column of zinc with dilute sulphuric acid. This acid is made up of one part of acid of 1.84 sp. gr. to two parts of distilled water, and is used throughout in all work upon iron determinations. Of this about 30 c.c. is taken, transferred to the cup *A*, and diluted to 300 c.c. Stop-cock *G*, is opened for suction, and then the three-way cock *C* is turned to discharge the cup *A*. A vacuum of 5 to 6 pounds or more, gauge indication, must be used, since the large volume of disengaged hydrogen retards the filtration. The cup and the column of zinc are then washed free from acid by five rinsings. This operation is repeated four times, and is then finished for this tubeful of zinc.

Below is a series of trials, undertaken to determine the proper correction for iron in the zinc. Owing to the small amount of reagent required for the end-reaction, it was impossible to obtain a reading under 0.1 c.c., which, as will be seen further on, is too much for even so large a quantity of zinc.

No. of Test.	Amount of $K_2Mn_2O_8$ c.c.
1	0.4
2	0.2
3	0.13
4	0.12
1	0.4
2	0.2
3	0.15
4	0.13
1	0.4
2	0.15
3	0.13
4	0.11
1	0.4
2	0.2
3	0.13
4	0.1

These were made at different times upon new quantities of zinc, and with solutions of $K_2Mn_2O_8$, of slightly varying strength. Beyond the fourth trial in each case, it was impossible to get less than one drop of the reagent into the solution. This is nearly 0.1 c.c. and in every instance gave a strong coloration.*

Evidently the largest amount of iron in the zinc is only on the outside of the particles, as the quantity dissolved in the reducer is less than five grammes for each filtration. By the ordinary method of dissolving all the zinc, the correction is rarely below 0.15 c.c. for 5 grammes.

Exactly the same procedure is adopted to reduce a ferric sulphate solution, except to use both cups *A*, and *B*. After the first is emptied it is washed with cold water five times. This incidentally cools the column of zinc and retards unnecessary solution. The other cup is then connected by turning the three-way-cock *C*, and washed in like manner. In each case this suffices to free the apparatus from all traces of iron or sulphuric acid. *G*, is then closed, the three-way-cock is turned again to relieve the pressure, and the flask is removed. Time for reduction, two minutes.

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* I have since obtained a reading down to 0.03 c.c. by closing the burette-tip.

Solutions obtained in this way are beautifully clear and perfectly reduced. The volume and temperature are practically constant: the former being about 400 c.c., and the latter about 40° centigrade. Uniformity marks the entire process, and there is a minimum quantity of zinc sulphate. Dilute solutions must be used. There should be not over 50 c.c. sulphuric acid in 300 c.c. of the ferric solution ready for reduction.

An experiment was tried in reducing the solutions, after oxidation, used in standardizing the permanganate. Iron wire taken at .996 Fe.

Standardization.

	Weight of Wire, grm.	$K_2Mn_2O_8$ c.c.	Reaction.	Factor.
No. 1.	0.1271	16.48	Tinged	1 c.c. = .007681 Fe.
No. 2.	0.12175	15.78	Sharp	1 c.c. = .007684 Fe

Reduction of these Solutions.

	Reduction.	$K_2Mn_2O_8$ c.c.	Reaction.
No. 1.	Complete	16.42	Tinged.
No. 2.	"	15.8	Sharp.

This treatment applied to a hematite ore, gave (No. 2969)

	Weight of Ore, grm.	Reduction.	$K_2Mn_2O_8$ c.c.	Reaction.	Iron, per cent.
No. 1.	0.1527	Complete	7.2	Tinged	34.7207.
No. 2.	0.1526	"	7.2	Sharp	34.7441.
(Reverted: filtered through the Reductor.)					
No. 1.		Complete	7.2	Sharp	
No. 2.		"	7.2	"	

Direct determination of metallic iron in the wire used in standardizing gave the following results: Weight of wire, 0.12405 grm. dissolved in sulphuric acid and oxidized. Reduced by fil-

Reduction.	$K_2Mn_2O_8$ c.c.	Reaction.	Iron, per cent.
Complete	16.07	Sharp	99.5420

Factor, 1 c.c. $K_2Mn_2O_8$=.007684 Fe.

tration. Solution again reduced by filtration. Reduction complete. $K_2Mn_2O_8$, 16.10 c.c., as compared with 16.07 in the former reduction. Difference, 0.03.

The *apparent* correction for iron in the zinc is the increase in last reading or 0.03 c.c. of the reagent. Time required to reduce and titrate this solution twice, *ten minutes.*

While the apparent correction is thus 0.03 c.c., it is inadvisable to use it as a constant, since the true correction can be applied for each case, and is really variable, depending upon acidity and degree of saturation.

In the following example, the test of a hematite-ore (No. 2922), carried through in duplicate, the ferric sulphate was first reduced by the usual method of adding the zinc to the solution and then entirely dissolving it, and deducting 0.3 c.c. as the correction after titration. Each solution was then filtered through the reductor, and on the supposition that for each treatment with zinc (on account of filtration) but 1.0 c.c. is to be deducted; the results are seen to be coincident. By " reverted" is meant filtered through the reductor. The value of 1 c.c. $K_2Mn_2O_8$ is .007678 Fe.

	Weight of Ore, grm.	Reduction.	$K_2Mn_2O_8$.	Correction.	Iron, per cent.
No. 1.	0.1360	Complete	7.4 sharp	0.3=7.1	40.06
"	Reverted	"	7.3 "	0.2=7.1	40.06
No. 2.	0.1379	"	7.49 "	0.3=7.19	=40.03
"	Reverted	"	7.39 "	0.2=7.19	=40.03

Another (No. 2971) with a difficulty-fusible residue, was tried directly, each solution being reduced twice by filtration. Time for reducing and titrating in duplicate, twenty minutes.

	Weight of Ore, grm.	Reduction.	$K_2Mn_2O_8$ c.c.	Reaction.	Iron, per cent.
No. 1.	0.1505	Complete	9.27	Sharp	
2d trial,		"	9.21	"	= 47.0230
No. 2.	0.1823	"	11.29	"	
2d trial,		"	11.23	"	= 46.9132

Assuming that for ordinary purposes the correction obtained by reverting the solution used to standardize the permanganate would be a safe one, I have applied it to the determination of iron in an ore with the following results:

Standardization.

	Weight of Wire, grm.	$K_2Mn_2O_8$ c.c.	Reduction.	Correction, c.c.
No. 1.	0.11915	15.48		
"	Reverted	15.55	Complete	0.07
No. 2.	0.1261	16.4		
"	Reverted	16.44	"	0.04

Factor, 1 c.c. $K_2Mn_2O_8$=.007664 Fe.

Determination.

(No. 2997)	Weight of Ore, grm.	$K_2Mn_2O_8$ c.c.	Correction.		Iron, per cent.
No. 1.	0.1576	9.58	0.07	9.51	46.246
No. 2.	0.2351	14.3	0.07	14.23	46.388

In like manner a rich hematite-ore (No. 3066) gave

No. 1, weight of ore, 0.2302 grm.; metallic iron, 60.03 per cent.
No. 2, " " 0.1645 " " " 60.17 "

Theoretically a neutral or nearly neutral solution of ferric sulphate should be reduced by zinc in this way without dissolving the latter appreciably, at least, not to the extent of introducing the error due to its impurity. As nearly satisfying these conditions, by the use of a minimum of sulphuric acid, the two following examples afford a remarkable demonstration. The experiments were conducted like the foregoing. Factor 1 c.c. $K_2Mn_2O_8$ =.007656 Fe.

No. 1, Weight of Wire, 0.12085 grm.	Amount of $K_2Mn_2O_8$ c.c.
1st trial,	15.72
2d trial,	15.78

No. 2, Weight of Wire, 0.11315 grm.	$K_2Mn_2O_8$ c.c.
1st trial,	14.695
2d trial,	14.695

Metallic iron 99.432 per cent.

There appears to be a deeply-rooted belief that iron is the only impurity in pulverized zinc which reduces the $K_2Mn_2O_8$; but I think the error is in nearly all cases largely due to the carbonaceous residue. Five grammes of zinc were dissolved in sulphuric acid, and then found to require 0.13 c.c. of $K_2M_2nO_8$.

After oxidation, a test of the solution gave *no* coloration with potassium sulpho-cyanate. Oxidation with nitric acid gave a like result.

Twenty-five c.c. of sulphuric acid were diluted to 300 c.c., and passed through the reductor. $K_2Mn_2O_8$ required 0.05 c.c. One drop more was added and the solution allowed to stand until clear. It was then tested with potassium sulpho-cyanate, and gave *no* coloration. A like experience followed in repeated trials of dissolving the zinc directly; but subsequent treatment of these solutions with ammonia and filtration gave evidence of iron. A determination of iron in the zinc used in these experiments gave the following: 5 grammes of zinc were dissolved in sulphuric acid. $K_2Mn_2O_8$ required 0.1 c.c.=0.0154 per cent. iron. As in the first case, 5 grammes were dissolved and the solution filtered through the reductor. $K_2Mn_2O_8$ required 0.12 c.c. Increase, 0.02 c.c., equivalent to 0.0030 per cent. iron.

Mr. P. W. Shimer has since suggested to me the probability of iron or manganese existing as some compound in the black carbonaceous residue. This view seems confirmed by the fact that ignition of the residue leaves a small fused mass which, on dissolving in hydrochloric acid, reveals iron by the sulpho-cyanate.

May not this residue be soluble under accidental conditions when exposed to the action of the solution for an hour or more by the old method of reduction? I have frequently noticed that it is perceptibly smaller in bulk. Again, if the solution is warm, may not final oxidation of the ferrous salt have an effect in dissolving it?

If it should prove to be a carbon compound, the reducing action on the $K_2Mn_2O_8$ would be increased beyond the correction for iron as ordinarily obtained. Filtration undoubtedly obviates these difficulties.

As touching this reducing action, the following experience may be cited. An analysis in duplicate by the old method, gave an unaccountable difference in results. The one solution, with the high result, was noticed to have a dark color and lustre. Subsequently this proved to be due to a very finely divided sediment, apparently carbon.

(No. 2978)	Weight of Ore, grm.	Reduction.	$K_2Mn_2O_8$ c.c.	Correction.	Iron, per cent.
No. 1.	0.2174	Complete	11.75	0.3	40.47
No. 2.	0.1795	"	11.12	0.3	46.31
No. 3.	Reverted	"	9.61	0.15	40.49

Factor, 1 c.c. $K_2Mn_2O_8$=.007684 Fe.

Here is another similar case:

	Weight of Ore, grm.	Reduction.	$K_2Mn_2O_8$ c.c.	Correction.	Iron, per cent.
No. 1.	0.1951	Complete	16.95	0.18	65.80
No. 2.	0.1928	"	15.6	0.18	60.92
No. 1.	Reverted	"	15.9	0.3	61.21

Factor, 1 c.c. $K_2Mn_2O_8$=.007656 Fe.

The following test of an ore is added as an illustration of the capability of this method for rapid reduction. 1 c.c.=.007671 Fe.

	Weight of Ore, grm.	Reduction.	$K_2M_2nO_8$ c.c.	Correction.	Iron, per cent.
No. 1.	0.1566	Complete	13.35	0.05	66.1496
No. 2.	0.1820	"	15.51	0.05	65.1569

Time required to reduce and titrate in duplicate, twenty minutes.

The investigation of this principle of reduction, which I believe to be new, has been governed by the time afforded in the few and brief intervals of regular technical work. I think the method capable of still further advancement and application. At the present stage of the inquiry, it presents the most rapid and accurate treatment for the estimation of iron.

The apparatus was made by Emil Greiner, 63 Maiden Lane, New York, whose intelligent and skillful workmanship has been of great service to me.

PROCEEDINGS OF THE ENGINEERING SOCIETY.

Sept. 24, 1891.—President Coleman in the chair, R. B. Olney, Secretary.

Following men from the engineering schools were elected: Boyd, Bray, Cressman, Haynes, Knox, McKenzie, O'Neill, Olmstead, Peck, Reynolds, Richards, Sage, Saulsbury, Shelden, Smith, Schotte, and Worman.

On motion, the initiation fee was made $1; annual dues 50 cents. President Coleman gave a short account of the standing of the society and Mr. Davis made a financial report, after which Mr. Gjertsen read a very interesting paper on "The Secondary Apparatus Used on the Holton Base Line in Holton, Indiana." Drawings and photographs were used to illustrate. (Unfortunately the article cannot be reproduced, not having the permission of the Coast Survey to do so.)

The following paper was read by Mr. Cobb on

STONE CUTTING AND CONSTRUCTION AT THE ST. MARY'S FALLS CANAL.

After the preliminary plans and elevations of the lock have been drawn and approved, a plan is made of every course of stone in the structure. Each stone is numbered so that it can be readily referred to. The object of having a plan for every course is to ensure perfect clearness in the working drawings. No mistakes can then result from a confusion of the lines belonging to different courses.

The next step is to draw on a larger scale the plan of each stone in the lock and to put down on it all the dimensions and its angles, together with the radii of the curved sides. The number corresponding to that on the course-drawing is also put down. A dozen or more of these enlarged drawings can be put on one sheet, and after being traced a blue print is sent to the engineer in charge of pattern cutting. His draughting tools are an awl, a straight-edge, a scale, and a number of beam compasses of various radii. These compasses are made by driving a needle through each end of a wooden rod and fastening with glue.

The material out of which the patterns are made is sheet zinc. Lines are scratched in the metal by the awl running along the straight-edge. Right angles are invariably laid off with the beam compasses by the well known geometrical construction. An acute or oblique angle may be described by using the relations between the trigonometrical functions of the angle. The beam compasses are also used to describe arcs of circles. In one case a compass had to be constructed to draw an arc of radius 76 feet. It was built up of boards and scantling and the arc was actually drawn. It is doubtful if a larger compass was ever used.

The use of beam compasses in laying off angles is found necessary to ensure the required degree of accuracy, which is that the error of any dimension of the pattern shall be less than $\frac{1}{32}$ of an inch. When we remember that many of these patterns have sides six feet long we can easily see that the work must be performed with care. Several tinsmiths are kept busy cutting out the work as fast as finished by the engineer. The patterns are finally fitted together upon the floor of a large warehouse to check the work, but this is hardly necessary owing to the care and accuracy with which it is done. The zinc is then sent to the stoneyard and the stone is there reduced to the required form as indicated by the patterns.

In all this work nothing is said concerning the thickness of the blocks of stone. This is uniformly two feet, except in a few special cases, and for these further details are given.

The joints in this work are ⅜ of an inch and the bond 1½ feet. The dimensions of the stones are made even feet from centre to centre of joints, therefore the thickness of joint must be subtracted from each dimension before it is put down upon the working drawings. The pattern cutter would then for a stretcher 3×6 feet cut a sheet of zinc 5 feet 11⅝ inches long and 3 feet wide.

The cubic contents of each stone is figured with precision since it is the basis of determining the contractor's pay. The government furnishes all the stone and cement, so that the quality of it may be undoubted. The contractor is paid for actual stone laid, and to determine this a curious method is used. A barrel of cement is mixed with sand and water in the required proportion and made into bricks. These bricks are carefully measured and the cubic contents of the bricks made from one barrel of cement is multiplied by the total number of barrels of cement used by the contractor. This gives the number of cubic yards of cement in the masonry. If then we subtract this volume from the volume of the masonry as measured we will get the actual amount of stone in the structure, and the contractor is paid for laying this only.

For facing, a higher price is paid than for backing. The amount of the latter is easily obtained by subtracting the known volume of the face stones from the entire mass of stone work. The object of this device is said to be to protect the government from an undue use and waste of its cement. Every barrel of cement is tested before being used, and all the work of construction watched and directed by the engineers of the army corps.

In viewing the work we are impressed chiefly by the extreme accuracy and care used. No makeshifts or approximations of any kind are tolerated. Every calculation must be theoretically correct and carefully checked to avoid mechanical error. The stones are laid with great exactness, and to accomplish this the alignment is largely done with a transit. This precision is maintained throughout the work and the result is a structure solid as the rock on which it stands.

On motion, meetings to be held the last Thursday of each month.

'91 CLASS POEM.

O Alma Mater, we, about to leave
Thy hallowed walls, a last farewell would give;
A sad farewell to life upon this soil,
A life of pleasure and of earnest toil.
This be our primal duty on the day
Ere we break loose from thine endearing sway.

Four years—how quickly sped! Each well-known spot
So often seen, will never be forgot.
This oft-trod ground may never be retrod,
Yet there's a voice in every springing clod
That calls, and will not hush through all our life,—
'Twill fill our minds with myriad memories rife.

Yon, where the Chapel rears its stately walls,
Where clarion-voicèd duty daily calls,
Our souls, uplifted on the waves of sound
Rolled from the golden organ's vast resound,
Have oft been moved to thoughts of deeper life,
Soothed by a moment's respite from our weary strife.

But oh, it would require a voice of might
To tell how Packer's turrets crown the height;
How from her tower the silvery bell-notes call
To sing the busy jostling in the hall,
The bulletins proclaiming notes of doom,
The many-tongued confusion of Jim's room,
The wan-faced, anxious youths, like close-shorn lambs
Loitering regretfully to their re-exams,
While glowing smiles do here and there foretell
A hard-earned eight-five, and deservèd well.

With dread I near that awful hall of state,
Whose yawning portals every week await
A band of culprits. How each little sin,
Each petty thoughtlessness comes swarming in
One's 'wildered brain, until it is a wonder
That this small band is left, surviving all that thunder.

And now it all is past, and here we stand
Before the open gates of a new land,
Untried, untrodden, what will come—unknown
Whether a stone for bread or bread from stone;
Yet, armed with the strength our Alma Mater gives,
Knowing her faithful while her last son lives,
Go forth, to will, to battle, and to do,
Still to thy comrades and to Lehigh true.

And may years follow years, each better than the last
Richer in promise, in result more vast,
Until, success enthroned on every brow,
We meet again here as we're gathered now,
Lay at our mother's feet the wealth we bring,
And in a wild burst of lyric beauty sing!

For, lo! on the rim of the world,
  Out of the gloom and the grief,
A flag of light is unfurled,
  An earnest of future relief.
And the years that are coming will reap
  From the field that the present has trod,
Till our souls arouse from their sleep,
  And awake in the dawning of God.

EDITORIALS.

THE QUARTERLY has made a later appearance this term than was to have been expected. We sincerely hope, however, that the delay has in no wise diminished, but rather increased, the pleasant anticipations of our readers.

WE have oftentimes questioned ourselves, without ever once having received a plausible answer to our query, why it is that the undergraduate body of this Institution should take such an inactive part, and show such marked disinterestedness in all that does not bear directly upon athletics.

We do not mean to frown upon so laudable an ambition as that of becoming preëminently successful in all the sports of the field, nor to criticise the interest thus displayed as being misplaced; on the contrary, we can scarcely find words wherein to express the praise which is most justly its due.

But in marked contrast to the Herculean efforts of the University to maintain her teams by giving the material out of which they are gradually erecting their triumphal arches, stand the puny endeavors of the undergraduate body to patch up and repair some of her oldest institutions and customs which are falling, little by little, step by step, into insignificance and decay, mayhap into darkest oblivion.

Neither can considerate and proportionate aid, pecuniarily or otherwise, be looked for in any enterprise or undertaking which has upon its front the stamp of newness, though the object of such undertaking be for the interest of our University.

We have but to revert to the buried Past to corroborate the truth of these statements. Take, for instance, those customs, though of minor importance, peradventure, which, in ye olden days, were so pregnant with interest.

The "Mustard and Cheese," by which, in former times, we were so appetizingly entertained, has now, by reason of a gross neglect, become so rank that none dare even mention it, much less bring it more materially to our notice.

The "Chemical Society" and many others of a similar character are almost pulseless organizations. They have, to all appearances, outlived their usefulness, inasmuch as they exist now only in name, and no effort is made to revive in them that pristine energy and vigor with which they were endowed.

Nor is this all. Would that the rest, which is a burning shame to the students themselves, might be left unsaid. The season is a fitting one, however; and as there is room for a much needed reform, there should be ample time for its consummation.

We need only mention the last Founder's Day hop, which represents very correctly all the others; 'Ninety-two's *Epitome*, and the last entertainment of our Musical Organizations, to acquaint our readers of our meaning.

It is generally known, without doubt, that at the hop ten undergraduates represented the 500 students of the University; that 250 *Epitomes* or thereabouts only were sold to that same body, and that only 65 active members of the University, including deadheads to a number exceeding 20, were counted among the audience at the last entertainment of the Musical Organizations.

Now students, gentlemen, we appeal to your sense of justice! Do you think you are conferring an honor upon those several men whom you elect to stand the burden and extra expense of making your customs successful, or do you perceive that you are placing upon their shoulders a responsibility which, in a measure, should be shared by you?

Is it not rather selfish, to say the least, for you, who are, indeed, "parts of this stupendous whole," to share among you the honors which fall thick and fast upon the University through the medium of her organizations, teams, journals, annuals, etc., when you do not lend them your much needed patronage and aid, neither by your purse nor by your wit?

It now only remains to point out the ultimate result of such action on your part.

The hour is not far distant when such penurious conduct will prove your embarrassment. The time draws on apace when sensible men, perceiving the weight of the yoke, will no longer suffer it to be placed about their necks. Beware the dawning of that unlucky day!

THE foot-ball situation has been too thoroughly discussed and is too well understood to need further comment from us. We will here, however, seize the opportunity of congratulating the management upon the success it has thus far obtained, and of expressing our confidence in the victorious future which yet awaits the team.

FEW exchanges have made their appearance this term. There were many that came last term, too late to be acknowledged. These we have since reviewed with much gratification. We were pleased to see the following statement in a very interesting article by Alfred E. Hunt, S.B., president of the Pittsburgh Reduction Company, on "The Properties, Uses, and Processes of Production of Aluminum," published in the *Technology Quarterly:*

"I wish to acknowledge my indebtedness to Mr. Joseph W. Richards, of Lehigh University, not only for personal statements and suggestions, which I have embodied in this lecture, but also for data from his admirable book on Aluminum. It is the first work on the subject printed in the English language, and I prophesy that it will always hold an authoritative position among the best treatises on the metallurgy and properties of aluminum, a place akin to that held by Percy's "Metallurgy of Iron and Steel."

RESOLUTIONS OF THE FACULTY.

WHEREAS, It has become necessary to increase the income of the University in order to meet the annually increasing expenditures required by the large number of students who seek instruction at our institution; therefore

Resolved, That tuition fees as follows be charged: In the technical courses, $100 per annum, $40 for the first term and $60 for the second term; in the school of general literature $60 per annum, $25 for the first term and $35 for the second term. This charge shall go into effect for all students applying for admission on and after January 1, 1892, and is not to be applicable to students now in the University or to those who have made application to be admitted, or who shall make application before January 1, 1892. That this fee shall include all tuition, the use of the library and gymnasium, but as heretofore the student shall be charged for materials and apparatus consumed in the laboratories.

Resolved, That from time to time the Trustees will place at the disposal of the Faculty a number of free scholarships, to be awarded to applicants of good moral character who shall pass the entrance examinations creditably, and who for other cause shall be regarded as worthy by the Faculty.

Rt. Rev. N. S. Rulison,
President of the Board,
Rt. Rev. M. A. DeW. Howe,
Robert H. Sayre,
William H. Sayre,
John Fritz,
Eckley B. Coxe,
Elisha P. Wilbur,
James I. Blakslee,
H. Stanley Goodwin,
Charles Hartshorne,
Trustees of Lehigh University.

It can be seen from the foregoing preamble and resolutions, unanimously adopted by the Board of Trustees of the University at their last meeting, that a very important and decided step has been taken in regard to free tuition.

Directly the student body is not affected, but indirectly it certainly will be, inasmuch as it will raise or lower the standing of the University. A man, when he enters the active life for which he is now preparing, is judged by the standing of his Alma Mater.

An idea may dwell in the minds of a few that the conditions of entrance must be made easier in order to secure a sufficient number of students to produce an income ample enough to meet all possible needs. Such a suspicion might possibly arise in the case of a college depending entirely upon tuition for its support. To think such a thing of Lehigh would certainly be unjust.

Heretofore the students have not contributed one cent as tuition, and so far as an income has been concerned it made no difference whether there were five or five hundred taking advantage of the opportunities afforded. For a time at least the number of students applying for admission will be smaller than usual, but it is almost as certain that there will be no loss in quality.

It is a well known fact that many will not come here on account of this very thing, afraid that it is somewhat degrading to attend a place of learning where there are no tuition charges. The advantages in having such students as these are not very apparent, however.

On the other hand, Lehigh has reached the position she now occupies because she has asked nothing from her students and has been independent, not being obliged to consider them as a source of revenue. But now her reputation has attracted so many applicants and, in spite of the strict conditions attending entrance so many have succeeded in entering, that the income is only sufficient to meet the ordinary running expenses and not at all large enough to relieve the University of the strain placed upon it by reason of the need for a larger body of professors and instructors, more laboratories, apparatus, etc. It is not a case of policy, but a case of necessity. The income to be derived in the future from incoming students will relieve it and allow the so much needed extensions to be made.

The life of Lehigh does not depend upon this new step, but it will increase the usefulness, better the facilities for imparting knowledge, and make for it such a reputation as will force all to acknowledge that Lehigh stands at the head of the technical schools in this country. The granting of scholarships will also tend to raise the standard and promote a desire on the part of those entering to attain a high standing.

The prices of tuition as they have been fixed may cause some discussion, but they are lower than those in nearly all other technical schools by a number of dollars, and if it is a case of dollars and cents Lehigh certainly gives more for the money than any other.

WAIFS AND STRAYS.

THE editor, mindful of posterity and of those future loiterers of a century hence in the quiet alcoves of the then old University library, who will come to turn the pages of an early QUARTERLY to catch a glimpse of the daily aspect and homely fact of our day, which will then be only a remembrance just as the early days of Harvard are to her sons of this decade, puts here on record for his unborn reader, whom he salutes as the child of our common Alma Mater, trusting that the old familiar bell of Packer Hall will not too soon break in upon his quiet, that the early autumn of 1891 has brought but little beyond the ordinary course of events. As years go, this bids fair to be no worse than usual, and in fact the outlook generally is bright. True progress is ever slow, comparatively, and from year to year is often unnoticed, till all at once it breaks upon us as we survey the distant past from our vantage-ground of today. The most memorable thing, perhaps, that can be chronicled of today, is that Alma Mater has taken under her protecting arms a greater number than has ever before appeared in her halls. Senior, Junior, Sophomore, Freshman—all are with us—some more—some very much more—some less. The Senior, not unlike those of his name who have gone before, trying hard to realize that the last transformation has made as great a change in himself as it appears to have done in the eyes of others—a dignity to assume that in himself he wonders if he can live up to. A strange, perplexed feeling of mingled pleasure and pain, pride and humility, that perhaps from the very nature of himself and his surroundings comes at no other time in his life. Yes, gentle reader, in the alcoves of a century hence—for perchance thy fair form may grace the dusty nooks and labyrinths of learning's storehouse of that future time when Lehigh's halls are open to her daughters as well as sons—yes, the Senior of this, the last decade of the nineteenth century, is perhaps not unlike the upper classman of a century hence, and so perhaps in your day, as in ours, that oldest of the sciences, the greatest senior of them all, astronomy, lends its name to give an appearance of soberness and sanenss to much e that to unbiased minds might seem to be controlled by the same great luminary that rules our tides. The man in the moon no longer occupies first place, having resigned in favor of his fairer rival; and under certain circumstances, as regards time and place, the man of our time is apt to show a wonderful interest in the science, especially if *she* will deign to turn professor, and, professing not to know anything about it, will endeavor to make perfectly plain, just where this "girl in the moon" is. We protest that we have betrayed no confidences in saying this, and if the future reader will but insert *her* name, it will be as true for that time as for this.

If in your time, as in ours, the moon, like the weather, is a frequent and exhaustless topic of conversation, speak it fair and do not deride it, for as George William Curtis says in speaking of the weather, "as from the Roman forum, roads lead to all the world, so from topics like these, seemingly unrelated, suggestions may arise;" and there is hardly anything so uncertain as to where one's thoughts will lead if given full reign. Strange it is what paths a man's thoughts, and words too, may sometimes take when there is a source for his inspiration. And did ever a man live who had no one, or no thing, to inspire him, to urge him on, to show him the possibilities of life, alas! so often far different from the probabilities as it would seem from looking back upon it?

The Junior, scarcely of less importance—at least in his own eyes—fills a place that custom has made and tradition still keeps for him; one that to an under-classman is a much longed for and highly prized position. He is privileged to wear a silk hat, be somewhat of a social lion, is supposed to be free from the confining work of the former years, (at least he rarely works hard,) is always looked up to by *his* juniors as having been in love and being an authority on such matters, and all that. "And all that," we say, for if, gentle reader, you have gone thus far, it will not be without meaning to you. A comparative freedom from responsibility during the Junior year helps to make the traditional Junior of today, the happy, honest, careless fellow that he is; graduation, so far off that it is rarely seriously thought of, and the possession of the ripe (?) and varied experience of the first two years, are two large factors in the Junior's career. Then, too, the Junior edits the *Epitome*, and who but the same is privileged to make up the deficit of the June hop, unless by some unforeseen circumstance it should pay for itself?

"Of all strange things of tongue or pen" the strangest would be a University without a Sophomore class; and who would not sometimes, for an hour or so, be back again in his Sophomore year with all his old surroundings, both material and mental? Any one whose memory lingers at all upon his college days, must of necessity give a large part to this year. How little a thing will here conjure up a host of thoughts, each following in the train of the preceding. How full of memory to some, will be words like these: "Monument K," "The Mountain," and "Charlie's"; or how the thoughts of a class-supper will recall other things not likely to be forgotten when such good reason for remembering them exists. The Sophomore is enthusiastic; you can see that plainly in everything he does. He is combative, too, largely because he feels he ought to be, and not always from an inherent desire, as is often ascribed to him. There is something attractive about this year when viewed from the future,—an indescribable something that is the spice of college life. Just what the Sophomore of a century or two hence may be, can be better told then than now, and if this falls under the eyes of one of that time, things may have changed.

But it is safe to say that Freshmen will always be Freshmen as long as Universities are Universities. Freshman year is at once the longest and yet the shortest of any of the four years. And what vivid recollections every one retains of impressions, thoughts, and actions of it. Some of us can recall with the greatest clearness every incident in some episode of our first year, and perhaps not a few will remember with equal distinctness a time when a black-banded missive was soon followed by a seeming chaos in which masks, ropes, whips, and "paths that were rough and stony" figured largely. Surely, every Freshmen has much to remember, and did he but know that never again he would see through the same glasses, he might often act differently. This at least can be said for the Freshman,—he is receptive and readily and soon adapts himself to college custom; and then when one is a Freshman he knows more men, at least by sight and name, than at any other time in his whole course. This is almost invariably so.

But, after all, the whole thing is comparative, and when the Alumnus leaves his Alma Mater to start that course that lasts as long as life, he must of necessity be as much of a novice in comparison with some of his co-workers as ever the Freshman is, compared with the Sophomore, Junior, or Senior.

ORIGINAL, AND GOOD.

A LEGEND.

I read this legend once: A man of sin,
  Whose soul was unto God a crimson stain,
  One who had sought remission and in vain,
One night, on coming to the entering in
  Of a great city's gate, heard some one say
  That a saint's bones in the cathedral lay,

And that at daybreak they would be revealed,
  That he who was the first to look thereon
  Might be made clean of any evil done,
And any ill of body might be healed.
  Then, straightway casting off the cloak he wore,
  He ran until he reached the church's door.

But all the sacred precinct was befouled
  By human wretches fighting for the space
  Nearest the door; and when one lost his place
Or, slipping, fell, the others jeered and howled,
  And cast the fallen down upon the street
  Beneath the multitude's on-rushing feet.

He struggled through until he stood the first,
  Anyhow—biting, clawing, tooth and nail—
  He held his place. And when the night grew pale
With dawn, the doors behind him open burst,
  Thrust by the crowd, he stood weary and faint
  Before the covered relics of the saint.

Before they were revealed the priests intoned
  Words he heard not, for near him in the press
  Was wedged a cripple who hung powerless
Upon a crutch, and piteously moaned
  That being caught somehow in crowd's flight
  He had been brought to such an evil plight.

But he who had sought pardon through the years
  Then when the end of his life's quest was near
  Scorned not the helpless, but bent low to hear
An unknown cripple's lamentable tears;
  And reasoning, he spake thus in his heart:
"Assuredly, his miserable part

"Is worse than mine, since I shall soon be clean
Of all my ill." He paused. "Yet am I sure
That such deep guilt as mine admits of cure,
The sense of my past failures is so keen!
His ill is of the body, not the soul,
And my place would suffice to make him whole."

He hesitated till the time was come.
Then suddenly collecting all his strength
He raised the halt aloft at full arms' length,
Holding him so until his wrists grew numb.
And when his weighed arms sank again he saw
The cripple perfected of every flaw.

Senseless the sinner sank upon the ground.
Round him the lights seemed joyfully to roam
From lamps that swung in the cathedral dome
High in the incense, tremulous with sound
Of going footsteps; but his soul had passed
Before the rabble—purified at last. —*P. H. Frye.*

A WASTE OF TIME.

An invitation came to me
For Mrs. Bon Ton's masquerade,
And I, who longed for novelty,
The summons gratefully obeyed.

As sister Kitty was away,
I called to aid costumer's art,
And on the night of Folly's sway
I chose to play the Romeo part.

And played it well, beyond a doubt,
As Juliet will testify.
At early hour I found her out,
And ever at her side was nigh.

No charms for me had fairy queens
Or Japanese or flower girls,
I fain would be "behind the scenes"
With Juliet, the pearl of pearls.

A strangely sweet, familiar grace
Her every word and act revealed;
I begged, in vain, to see the face
Which her complete disguise concealed.

"Where have I heard that voice before?"
I reasoned thus within myself;
And then I lost my head still more
And rashly kissed the witching elf.

"Ah Jack! you're nicely duped," she cried,
The moment I had kissed her,
And, laughing, threw her mask aside—
Great Scott! it was—my sister. —*A. B. K.*

"GREAT accidents, before they happen to any city or province, are commonly prognosticated by some sign, or predicted by some men.

How it comes to pass I know not, but by ancient and modern example it is evident that no great accident befalls a city or province but it is presaged by divination, or prodigy, or astrology, or some way or other; and that I may not go far for my proof, every one knows what was foretold by Frier Girolamo Savonarola before the expedition of Charles the VIII into Italy, besides which it was reported all over Tuscany that there were armed men seen fighting in the air over the town of Arezzo, and that the clashing of their arms in the conflict was heard by the people.

It is generally known in Florence that before the death of the old Lawrence de Medici, the Tuamo or chief church in that city was struck with lightning, and the people destroyed; and before Piero Soderini (who was made Gonsaloniere for his life by the people) was banished and degraded; the palace was burned by lightning likewise. Many other instances might be produced which I omit for brevity sake. I shall only add one which is mentioned by Livy before the coming of the French to Rome. Marcus Ceditius, a plebian, acquainted the Senate that, passing one night about twelve o'clock through the Via Nova, he heard a voice (bigger than a man's) which advised him to let the Senate know the French were on their march to Rome. How these things could be is to be discoursed by persons well versed in the causes of natural and supernatural events; for my part I will not pretend to understand them unless (according to the opinions of some philosophers) we may believe that the air being full of intelligence and spirits, who, foreseeing future events and commiserating the condition of mankind, gives them warning by these kind intimations that they may the more timely provide and defend themselves against their calamities. But whatever is the cause, experience assures us that after such denunciations, some extraordinary thing or other does constantly happen. (Extract from "The Discoveries of Nicholas Michiavel upon the First Decade of Titus Livius," 1680.)

FOR LEHIGH MEN.

NOTES.

This column will contain, chiefly, such information in regard to addresses and occupations of Alumni as does not appear in the latest issue of the *Lehigh Register*. Please contribute.

'76. R. W. Mahon, A.C., Chemist, Maryland Steel Co., Sparrows' Point, Md.

'78. Milnor P. Paret, Member American Society Civil Engineers, 210 East Luxington Street, Baltimore, Md.

'78. H. F. Porter, Mechanical Engineer for World's Fair, 5063 Lake Avenue, Chicago, Ill.

'85. D. K. Nicholson, M.E., Superintendent Rail and Blooming Mills, Maryland Steel Co., Sparrows' Point, Md.

'85. J. B. Price, married Oct. 1st to Miss Mary Silliman, of Hazleton, Pa.

'85. C. M. Tolman, M.E., in charge of Electric Plant, Maryland Steel Co., Sparrows' Point, Md.

'87. R. W. Barrell, E.M., Manager Assaying Department, Last Chance Mining Co., Mogollon, N. Mex.

'87. F. H. Knorr, A.C., Union Ice Co., San Francisco, Cal.

'87. J. A. Morrow, C.E., Huntington Water Co., Huntington, W. Va.

'87. M. D. Pratt, C.E., Street Railway Engineer, Penna. Steel Co., Steelton, Pa.

'87. A. J. Wiechardt, M.E., Professor of Mechanical Engineering, New Mexico College of Agriculture and the Mechanic Arts, Las Cruces, N. Mex.

'87. H. A. Wilkins, B.S., E.M., Assistant Superintendent Zinc Mines, Franklin, N. J.

'88. C. L. Banks, B.S., M.D., 212 43d Street, New York, N. Y.

'88. W. D. Beatty, C.E., Elmira Bridge Co., 403 William Street, Elmira, N. Y.

'88. Wm. Bradford, C.E., Assistant Engineer, Citizens' Traction Co., 142 South Negley Avenue, Pittsburg, Pa.

'88. S. H. Jencks, Richlands, Tazewell County, Va.

'88. T. L. Matt, C.E., A. & St. L. R. R., Chasm Falls, N. Y.

'88. H. T. Palmer, P. W. & B. R. R., Wilmington, Del.

'89. F. J. Carman, A.C., Superintendent Manhattan Oil Co., Bradner, O.

'89. H. W. Chester, C.E., Beech Creek R. R. Co., Shamokin, Pa.

'89. J. C. Cornelius, C.E., Assistant Supervisor, New York Branch P. & N. Y. Div., Philadelphia & Reading R. R., Jenkintown, Pa.

'89. R. H. E. Porter, married Sept. 26 at Morristown, N. J., to Miss Edith Nast.

'89. A. K. Reese, E.M., Assistant at Blast Furnaces, Maryland Steel Co., Sparrows' Point, Md.

'89. J. R. Villalon, engaged at engineering work in Cuba.

'89. F. Weihe, Professor of Mechanical and Electrical Engineering, Delaware College, Newark, Del.

'90. F. R. Coates, B.S., E.M., Right of Way, B. & O. R. R., Pittsburg, Pa.

'90. H. K. Landis, B.S., E.M., Bethlehem Iron Co., Bethlehem, Pa.

'90. Geo. Nauman, Jr., C.E., P. R. R. Engineer Corps, 439 East King Street, Lancaster, Pa.

'90. Francis Thomson, M.E., Engineer Edgar Thompson Steel Co., Pittsburg, Pa.

'90. C. C. Thomson, M.E., Rail and Blooming Mills, Maryland Steel Co., Sparrows' Point, Md.

'90. S. D. Warriner, A.B., B.S., M.E., Engineer Department, L. V. Coal Co., 7 Franklin Street, Wilkes-Barre, Pa.

'90. J. E. Sanborn, A.C., Chemist Pottstown Iron Co., Pottstown, Pa.

'90. C. N. P. Turner, Edge Moor Iron Co., Wilmington, Del.

'91. W. A. Auchinvole, Head Chemist, Cambria Iron Co., Cambria, Pa.

'91. M. B. Augur, E.E., Assistant Superintendent of Bridges, L. V. R. R., Athens, Pa.

'91. J. E. Bucher, A.C., Student in Chemistry, Johns Hopkins, Baltimore, Md.

'91. J. B. Buckley, E.E., Thompson-Houston Electric Co., Room 613 Kirk Building, Syracuse, N. Y.

'91. J. S. Heileg, M.E. In Europe.

'91. P. D. Honeyman, E.E., 80 Lexington Avenue, New York, N. Y.

'91. H. I. Morris, M.E., Engineer in Construction, Maryland Steel Co., Sparrows' Point, Md.

'91. E. Vander Horst, C.E., Sanitary Engineer, Room 25 District Building, Washington, D. C.

'91. John Rose Davis, C.E., address, Port Jervis, N. Y.

'91. Alban Eavenson, A.C., Chemist for L. V. R. R., South Bethlehem, Pa.

'91. Walton Forstall, E.E., Engineer for Columbus Construction Co., Greentown, Ind.

'91. George S. Hayes, C.E., Engineer for Kellogg Iron Works, Buffalo, N. Y.

'91. H. M. Knapp, C.E., Snead & Co. Iron Works, Louisville, Ky.

'91. E. H. Coxe, C.E., with Norfolk & Western R. R., Ivanhoe, Va.

'91. C. M. Loeser, B.S., Bethlehem, Pa., Lehigh University.

'91. P. M. Paine, C.E., Assistant Engineer's Office, Philadelphia Division P. R. R., West Philadelphia, Pa.

'91. E. A. Quier, A.C., with Reading Fire Brick Works, Reading, Pa.

'91. I. A. Shimer, Clas., Instructor of Latin and French, Irving Institute, Tarrytown, N. Y.

'91. R. Paul Stout, M.E., Mechanical Engineer for Lehigh & Wilkes-Barre Coal Co., Audenried, Pa.

'91. W. S. Topping, B.S., Roland's Pharmacy, South Bethlehem, Pa.

'91. J. E. Talmage, D.S.D., Ph.D., F.R.M.S., A.C., President Latter-day Saints' College, P. O. Box 1047, Salt Lake, City, Utah.

'91. J. S. Lockwood, E.E., Testing Department, C. & C. Electric Motor Co., 402-404 Greenwich Street, N. Y.

'91. Wm. A. Heindle, C.E., Baltimore City Passenger Ry., Baltimore, Md.

'91. H. T. Morris, M.E., Maryland Steel Co., Sparrows' Point, Md.

'91. P. B. Winfree, C.E., and H. T. Stilson, C.E., are taking Post-Graduate courses.

PERIODICAL AND BOOK NOTES.

[A continuation of the list published on page 59 of Vol. I, No. 1, of THE QUARTERLY.]

A continuous key to the abbreviation of the names of periodicals can be found in Nos. 1, 2, and 3 of this volume. The following is added: Colliery Engineer, published in Scranton, Pa.; abbreviated "Coll. Engr."

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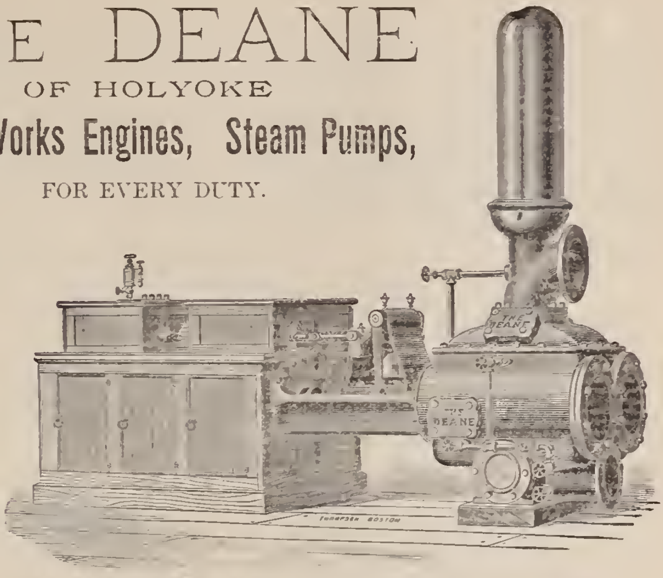

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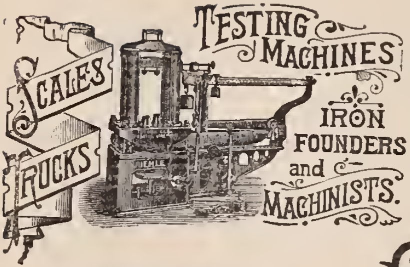

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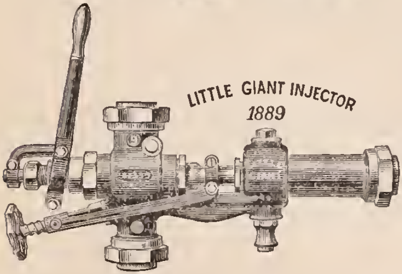

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